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ABHANDLUNG

Insurance guaranty fund—what good is it?

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Abstract In this paper, we analyze under which conditions a self-supporting insurance guaranty fund can be beneficial for the policyholders in an incomplete market. Within the analyzed setting, we find out that in general, if existent, the potential advantages from its introduction cannot be fairly divided among the participating insurers. Thereby, we have to expect systematic wealth transfers between the policyholders of different insurance companies. We introduce a framework for utility-based fund charges as a solution to this problem.

Zusammenfassung In diesem Artikel wird der Einfluss eines selbstragenden Konkurssicherungsfonds in der Versicherungsbranche auf die Vermögenssituation der Versicherungsnehmer in unvollständigen Märkten analysiert. Innerhalb des untersuchten Rahmens stellen wir fest, dass die etwaigen Vorteile, die ein solcher Fonds mit sich bringen kann, generell nicht verursachungsgerecht alloziert werden. Dies kann zu Vermögenstransfers zwischen den teilnehmenden Unternehmen führen. Als Lösung wird ein nutzenbasierter Ansatz zur Pämienbemessung vorgeschlagen.

Remark

This contribution summarizes the major findings of a working paper written by Rymaszewski et al. (2010) that was presented by Hato Schmeiser and Przemysław Ry-

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1 Introduction

The magnitude of losses throughout the current financial crisis has even jeopardized the existence of large financial institutions. Insolvency costs caused by the recent turbulences in the international financial markets did not only affect equity and debt holders, but, through the necessity of major bail-outs, also taxpayers and the whole society. However, making taxpayers pay for corporate insolvencies is hard to justify and might incentivize insurers to take more risks.

An insurance guaranty fund financed by all insurance companies in the market can be employed to force insurance companies to internalize the entire industry's insolvency costs. Its introduction is only one of many possible approaches for the attempt to install a controlled run-off system within the insurance sector. Nevertheless, since insurance companies are not homogeneous and differ in risk brought into the insurance guaranty fund's pool, the calculation of risk-based premiums and the definition of possible pay-outs from the insurance guaranty fund becomes a very important task in this context. If these aspects are not considered—as typically done in insurance practice[1]—one can expect adverse incentives for insurers and extensive cross-subsidization between market participants.

The goal of this contribution is to examine under which conditions the introduction of an insurance guaranty fund can be beneficial for policyholders. In a first step, we suggest that, if a contingent claim approach is applied in order to value the claims of an insurance company's stakeholders, policyholders cannot be made better off by the introduction of a fairly designed insurance guaranty fund. In a second step and in an incomplete market setting, we analyze under which conditions an insurance guaranty fund is advantageous for risk-averse policyholders. Possible diversification benefits through the introduction of an insurance guaranty fund are measured by an increase in the utility of the policyholders. The correlation between the fund's payoff and the insurer's assets as well as the premium level in the fund turn out to be important in order to draw benefits through the introduction of an insurance guaranty fund. If companies are homogeneous and diversification benefits arise through the insurance guaranty fund, the increase in utility is equally allocated to all participating policyholder collectives. However, we find that in the case of heterogeneous companies, an insurance guaranty fund is in general no longer beneficial—at least not to the same extent—for all policyholders of the different insurance companies on the market. As a possible solution to this problem, we introduce a concept of utility-based premium calculations within the fund.

The remainder of this paper is structured as follows. In Sect. 2, we give an overview of related literature. Section 3 illustrates the general setting used for the purpose of our analysis. We analyze the conditions under which an insurance guaranty fund can be beneficial in a contingent claims and utility-based context in Sect. 4.

[1] See, e.g., Brewer-III et al. (1997), Feldhaus and Kazenski (1998), Oxera (2007).

In Sect. 5 we discuss different premium principles in the utility-based setting. An exemplary payoff structure for the guaranty fund is given. Finally, in Sect. 6 we summarize.

2 Literature overview

A comprehensive discussion of the literature is presented in Rymaszewski et al. (2010). In the following we point out the main references.

Cummins (1988) argues that a well designed insurance guaranty fund should demand risk-based premium payments to avoid adverse incentives resulting from the information asymmetries between the insurer and the policyholders. If the insurer is not charged according to its risk, he may still be able to increase their market value by raising the volatility of their assets. This problem, also denoted as the risk-subsidy effect, is analyzed by Lee et al. (1997), who provide sound empirical evidence for its significance within the U.S. property-liability insurance market. They do not find any significant influence of the so-called monitoring effect, which may occur if insurers are charged ex-post with risk-inadequate fees. In such a context, insurance companies should have a greater incentive to monitor their competitors. This relation is closely connected to the monitoring abilities of insurance companies and their policyholders. If the insurers are able to monitor other insurance companies more effectively than policyholders are capable and willing to, this effect can be expected to be crucial. Nevertheless, a system of ex-post charges cannot be organized in a risk-based way due to the fact that the insolvent insurance company, which may have been the riskiest one, is typically not charged at all. This issue is extensively addressed by Han et al. (1997, pp. 1119). Brewer-III et al. (1997) support the previous results for guaranty funds effectively funded by taxpayers for the U.S. life insurance market. Downs and Sommer (1999) arrive at similar conclusions and extend their line of reasoning by insider ownership issues. Sommer (1996) provides empirical evidence for market discipline in the U.S. property-liability insurance market and puts it in the insurance guaranty fund context. He argues that fund charges based on the amount of insurance premiums earned by an insurer may even strengthen the risk-subsidy incentives.

The calculation of risk-adequate premiums is one of the most important tasks in the context of an insurance guaranty fund. Cummins (1988) suggests a premium principle based on option pricing theory. In his framework, assets and liabilities of the company are modeled as diffusion processes. He interprets the value of the hedge provided by an insurance guaranty fund as the price of a European put option on the company's assets with the value of liabilities as the strike. Duan and Yu (2005) extend the one-period model from Cummins (1988) into a multi-period setting. They incorporate interest rate risk and regulatory responses mandated by risk-based capital regulations.

3 The model framework

In this Section we describe the model framework applied within the analysis conducted in Rymaszewski et al. (2010). First, a general design of the analyzed insurance guaranty fund is presented. Second, we depict the resulting policyholders' wealth position. Finally, a general requirement for an insurance guaranty fund's payoff scheme is illustrated.

3.1 General design of the insurance guaranty fund

Consider a set $\mathcal{C} = \{1, \ldots, M\}$ of M mutual companies denoted by $i = 1, \ldots, M$, active on the market, and define $W_i^{(0)}$ as the aggregated premium paid by the policyholders of the insurer i at time $t = 0$.

If there is no insurance guaranty fund, policyholders of the mutual i are entitled to two stochastic stakes at time $t = 1$, namely the insureds' position and the owners' stake (see Fig. 1 in Rymaszewski et al. 2010 for an overview of the relevant cash flows). The insureds' position, whose value in $t = 1$ is denoted by $\tilde{P}_i^{(1)}$, grants the policyholders coverage of their aggregated stochastic claims $\tilde{S}_i^{(1)}$ each time the company remains solvent, i.e., the stochastic assets $\tilde{A}_i^{(1)}$ exceed the claims $\tilde{S}_i^{(1)}$. If claims exceed the assets of the insurer at time $t = 1$, i.e. $\tilde{S}_i^{(1)} > \tilde{A}_i^{(1)}$, policyholders receive solely the market value of assets—in this case, the company is insolvent. The owners' stake, whose value in $t = 1$ is denoted by $\tilde{E}_i^{(1)}$, is determined residually by the difference between the value of the assets and the aggregated claims at $(t = 1)$.

If an insurance guaranty fund is introduced, the company i pays a fraction $\pi_i^{(0)}$ of the aggregated premium $W_i^{(0)}$ into the guaranty scheme as an ex-ante charge. The insurance guaranty fund invests this premium on the capital market. This investment results in a stochastic cash flow $\tilde{\pi}_i^{(1)}$ at time $t = 1$.

At the same time, policyholders of the mutual do have claims with respect to the insurance guaranty fund. If the mutual is insolvent, full coverage of policyholders' claims can be provided as long as the insurance guaranty fund is solvent. If too many insolvencies occur and not enough capital is available in the insurance guaranty fund, only a partial coverage is possible. Let us denote $\tilde{\mathcal{P}}_i^{(1)}$ as the value of the claims of the policyholders of company i against the guaranty fund in $t = 1$. In addition, policyholders collectively enjoy an equity stake in the insurance guaranty fund. The value of this position from the point of view of the policyholders of company i in $t = 1$ can be written as $\tilde{\mathcal{E}}_i^{(1)}$. Hence, the joint position of the policyholders of the company i in the insurance guaranty fund can be written as $\tilde{F}_i^{(1)} = \tilde{\mathcal{P}}_i^{(1)} + \tilde{\mathcal{E}}_i^{(1)}$. The policyholder's and owner's stakes in the insurance company i change to $\tilde{P}_i^{(1),\mathrm{f}}$ and $\tilde{E}_i^{(1),\mathrm{f}}$, respectively. We assume that the premium obtained from policyholders of the mutual company i is the same with and without an insurance guaranty fund, which implies $W_i^{(0)} = W_i^{(0),\mathrm{f}}$.

3.2 Wealth position of the policyholder collectives

In a situation without an insurance guaranty fund, the wealth position $\tilde{W}_i^{(1)}$ of the policyholder group of the mutual company $i \in \mathcal{C}$ at time $t = 1$ is given by the sum of the insureds' position $\tilde{P}_i^{(1)}$ and the owners' stake $\tilde{E}_i^{(1)}$,

$$\tilde{W}_i^{(1)} = \tilde{P}_i^{(1)} + \tilde{E}_i^{(1)} = \tilde{A}_i^{(1)}, \quad \forall i = 1, \ldots, M. \tag{1}$$

Thus, the joint wealth position is equivalent to a long position in company's assets. We abstract from any other wealth positions and risk sources the policyholders of company i might face.

After the insurance guaranty fund is introduced and the fund premium $\pi_i^{(0)}$ is paid, the company assets decrease. In this case, the available assets at time $t = 1$ are denoted by $\tilde{A}_i^{(1),\star} = \tilde{A}_i^{(1)} - \tilde{\pi}_i^{(1)}$, $\forall i = 1, \ldots, M$. In order to simplify the analysis, we implicitly assume that the chosen asset allocation in the insurance guaranty fund for the respective premiums $\pi_i^{(0)}$, $i = 1, \ldots, M$, and in the insurance company i is identical. With introduction of the guaranty fund, claims against the fund, $\tilde{\mathcal{P}}_i^{(1)}$, as well as an equity stake in the fund, $\tilde{\mathcal{E}}_i^{(1)}$, arise and add up to the wealth position. Hence, the latter is equal to

$$\tilde{W}_i^{(1),\mathrm{f}} = \tilde{P}_i^{(1),\mathrm{f}} + \tilde{E}_i^{(1),\mathrm{f}} + \tilde{\mathcal{P}}_i^{(1)} + \tilde{\mathcal{E}}_i^{(1)} = \tilde{A}_i^{(1),\star} + \tilde{F}_i^{(1)}, \quad \forall i = 1, \ldots, M. \tag{2}$$

A minimal requirement on the structure of the payoff is given below in Sect. 3.3, an exemplary payoff structure is illustrated in Sect. 5.3.

3.3 Payoff scheme of the guaranty fund

The cash flow $\tilde{F}_i^{(1)}$ of the insurance guaranty fund is dependent on the number of companies M, their asset and claim distributions, $\tilde{\mathbf{A}}^{(1)} = (\tilde{A}_i^{(1)})_{i\in\mathcal{C}}$ and $\tilde{\mathbf{S}}^{(1)} = (\tilde{S}_i^{(1)})_{i\in\mathcal{C}}$, the correlation structures between assets and claims, as well as the premiums charged by the fund, $\mathbf{\Pi}^{(0)} = (\pi_i^{(0)})_{i\in\mathcal{C}}$, and their stochastic distribution at time $t = 1$, $\tilde{\mathbf{\Pi}}^{(1)}$.

In order to ensure proper incentives, the minimal requirement on the obligatory insurance guaranty fund is that it has to be self-supporting, i.e., at time $t = 1$, the sum for all companies of the expected fund payoff equals the sum of the expected premiums collected by the fund:

$$\sum_{i\in\mathcal{C}} \langle \tilde{F}_i^{(1)} \rangle = \sum_{i\in\mathcal{C}} \langle \tilde{\pi}_i^{(1)} \rangle. \tag{3}$$

This implies that, e.g., there is no external agent (e.g., taxpayer) that would have to cover a part of the default risk through (contingent) payments to the fund. Since the guaranty fund is required to be self-supporting, the derivation of an adequate structure for the payoff scheme is strongly determined. However, in general, various schemes can be derived, thereby implying different incentives for the market participants.

4 Evaluation of the insurance guaranty fund

4.1 Contingent claims approach

If $\mathrm{PV}[\tilde{F}_i^{(1)}] = \pi_i^{(0)}$, the present value of the policyholders' claims with respect to the fund equals the initial contribution, hence $\mathrm{PV}[\tilde{W}_i^{(1)}] = \mathrm{PV}[\tilde{W}_i^{(1),\mathrm{f}}]$. This condition is fulfilled in an arbitrage-free market. Otherwise systematic wealth transfers between different insurers would take place.

The safety level of an insurer changes ceteris paribus with the contribution $\pi_i^{(0)}$ in the fund. In addition, an agreed payoff scheme that defines the conditions under which payouts are made from the fund to the insurance companies will influence the distributions of $\tilde{\mathcal{P}}_i^{(1)}$ and $\tilde{\mathcal{E}}_i^{(1)}$. For instance, the probability that claims can be paid from the two sources (the insurer and the guaranty fund) will depend on the design of the payoff scheme and the premium payments in the fund. However, as long as the stakes are priced fairly, in this model setup the policyholders face neither an advantage nor disadvantage.

This situation may change, if the ability to diversify varies among distinct market participants. It can be the case in incomplete markets (see, e.g., Cochrane 2005), where investors cannot replicate all possible future cash flows. In general, one may assume that insurance companies and insurance guaranty funds are able to diversify in a better way than policyholders. If this is the case, the potential pooling effect of an insurance guaranty fund may enhance policyholders' wealth position and hence become one of the advantages in favor of its introduction. In such a setup, in order to value the diverse stakes, assumptions about the investors' preferences are needed.

4.2 A utility-based approach

4.2.1 Policyholders' utility function

Let us assume that the policyholder collective's utility for companies $i = 1, \dots, M$, at time $t = 1$ is described by the standard mean-variance utility function of their respective stochastic wealth position. In the setup without insurance guaranty fund, the wealth position of the policyholders of company i, $\tilde{W}_i^{(1)}$, is given by (1), and we introduce the corresponding utility $\phi_i^{(1)} = \langle \tilde{W}_i^{(1)} \rangle - \frac{a_i}{2} \mathrm{var}(\tilde{W}_i^{(1)})$, where a_i defines the risk aversion parameter. Similarly, in the setting with the fund and based on the stochastic wealth position of the policyholders $\tilde{W}_i^{(1),\mathrm{f}}$, introduced in (2), we introduce the utility defined by $\phi_i^{(1),\mathrm{f}} = \langle \tilde{W}_i^{(1),\mathrm{f}} \rangle - \frac{a_i}{2} \mathrm{var}(\tilde{W}_i^{(1),\mathrm{f}})$. The absolute change in policyholders' utility in company i due to the introduction of the guaranty fund, is denoted by

$$\begin{aligned}\Delta_{\mathrm{a}}\phi_i^{(1)} &= \phi_i^{(1),\mathrm{f}} - \phi_i^{(1)} \\ &= \langle \tilde{F}_i^{(1)} - \tilde{\pi}_i^{(1)} \rangle - \frac{a_i}{2} \left[\mathrm{var}\left(\tilde{F}_i^{(1)} - \tilde{\pi}_i^{(1)}\right) + 2\mathrm{cov}\left(\tilde{A}_i^{(1)}, \tilde{F}_i^{(1)} - \tilde{\pi}_i^{(1)}\right)\right]. \end{aligned} \quad (4)$$

4.2.2 Risk-neutral investors

If the policyholder collective of company j is assimilated to a *risk-neutral* investor, who by definition does not adjust for risk while making its financial decisions, it would be indifferent between both setups, without or with the guaranty fund, if $\phi_j^{(1)} = \phi_j^{(1),\mathrm{f}}$. This condition implies that $\Delta_\mathrm{a}\phi_j^{(1)} \stackrel{!}{=} 0$. Since in this case we have $a_j = 0$, we get from (4):

$$\Delta_\mathrm{a}\phi_j^{(1)} = \langle \tilde{F}_j^{(1)} - \tilde{\pi}_j^{(1)} \rangle \stackrel{!}{=} 0 \quad \Longleftrightarrow \quad \langle \tilde{F}_j^{(1)} \rangle = \langle \tilde{\pi}_j^{(1)} \rangle. \tag{5}$$

We conclude that the condition $\phi_j^{(1)} = \phi_j^{(1),\mathrm{f}}$ is fulfilled if and only if $\langle \tilde{F}_j^{(1)} \rangle = \langle \tilde{\pi}_j^{(1)} \rangle$. Since the guaranty fund is supposed to be self-supporting (3), Condition (5) is always accounted for on an aggregated level. Hence, if all investors are risk-neutral, there is no possibility to achieve a utility-based Pareto enhancement by introducing an insurance guaranty fund. In fact, in a self-supporting fund, violating Condition (5) for some company, can improve the expected value of the mutual stake in one insurer only by (negatively) influencing at least some of the expected values of the policyholders' payoff of the remaining companies. This means that in such a case some policyholders can benefit solely from the costs of other insureds.

4.2.3 Risk-averse policyholders

In what follows, we assume risk-averse policyholders, i.e. $a_i > 0, \forall i \in \mathcal{C}$, and analyze potential benefits from the existence of an insurance guaranty fund by an analysis of the (absolute) change in utility $\Delta_\mathrm{a}\phi_i^{(1)}$.

Pooling of claims in an insurance guaranty fund is beneficial from the perspective of the policyholders of the mutual insurer i if

$$\begin{aligned} \Delta_\mathrm{a}\phi_i^{(1)} > 0 \quad \Longleftrightarrow \quad & \langle \tilde{F}_i^{(1)} - \tilde{\pi}_i^{(1)} \rangle + a_i \big[\mathrm{cov}\big(\tilde{A}_i^{(1)}, \tilde{\pi}_i^{(1)}\big) + \mathrm{cov}\big(\tilde{F}_i^{(1)}, \tilde{\pi}_i^{(1)}\big) \\ & - \mathrm{cov}\big(\tilde{F}_i^{(1)}, \tilde{A}_i^{(1)}\big) - \frac{1}{2}\mathrm{var}\big(\tilde{F}_i^{(1)}\big) - \frac{1}{2}\mathrm{var}\big(\tilde{\pi}_i^{(1)}\big)\big] > 0. \end{aligned} \tag{6}$$

An interesting insight is that Condition (6) cannot be fulfilled whenever both the insurance company and the fund are investing only in risk-free assets. In this case all covariances in (6) are equal to zero. Hence, if $\langle \tilde{F}_i^{(1)} \rangle = \langle \tilde{\pi}_i^{(1)} \rangle$, we get $\Delta_\mathrm{a}\phi_i^{(1)} \le 0$. In order to achieve diversification, a positive asset return volatility is needed. Risk-free investments make the wealth position of the policyholders (see (1)) deterministic. An insurance guaranty fund leads to a positive volatility of the wealth position. Moreover, if $\langle \tilde{F}_i^{(1)} \rangle = \langle \tilde{\pi}_i^{(1)} \rangle$, its expected value is unchanged. This is strictly a disadvantage for risk-averse policyholders.

Since (6) contains the (complex) relationship between $\tilde{F}_i^{(1)}$ and the asset $\tilde{\mathbf{A}}^{(1)}$, claim $\tilde{\mathbf{S}}^{(1)}$, and premium distributions $\tilde{\mathbf{\Pi}}^{(1)}$ of all companies, an explicit derivation of necessary conditions for a positive diversification benefit is not practicable without loss of generality.

Finally, let us point out that the changes in utility implied by the existing guaranty funds are not, in general, identical for all market players. Since most of the existing national guaranty funds charge premiums based on companies' premium income (e.g., USA, UK, France), or their net technical reserves (e.g., Germany), this neither guarantees that the fund is self-supporting, as we require in (3), nor that different policyholder groups profit from an equal utility increase caused by the existence of the guaranty fund, as we discuss in Sect. 5.

5 Premium principles and payoff

The payoff distribution $\tilde{F}_i^{(1)}$ is strongly influenced by the premium principle used to derive $\pi_i^{(0)}$, $i \in \mathcal{C}$. As we assume that the insurer and the insurance guaranty fund choose the same fixed risky asset allocation, an increase in fund premium payments $\pi_i^{(0)}$ will result in an increase of $\mathrm{var}(\tilde{\pi}_i^{(1)})$. All elements in (6) would be influenced by an alteration of $\pi_i^{(0)}$. Hence, for the policyholders of the insurer i with a specific risk aversion parameter $a_i > 0$, there may exist a premium range where Inequality (6) is fulfilled. This premium range depends on the asset and claim distributions as well as their correlations between all insurers. In other words, we may calculate a premium $\pi_i^{(0)}$ that would set the policyholder's utility to a given level. Since premium levels are directly linked to the safety level (ruin probability, expected shortfall) of the companies, charged premiums are bounded from above by in-force solvency regulations (e.g. Solvency II, Swiss Solvency Test). Furthermore, the effect of the premium level on the diversification benefit and the augmentation of the safety level in case the guaranty fund is introduced have to be analyzed carefully.

5.1 "Fair" premiums in the general case

Whenever homogeneous companies are charged different premiums, or in the case of heterogeneous companies, the premium principle $\langle \tilde{F}_i^{(1)} \rangle = \langle \tilde{\pi}_i^{(1)} \rangle$ does no more hold in general for any $i \in \mathcal{C}$. Let us assume that we are able to find premiums $\mathbf{\Pi}^{(0)}$ such that the $\langle \tilde{F}_i^{(1)} \rangle = \langle \tilde{\pi}_i^{(1)} \rangle$, $\forall i \in \mathcal{C}$. Even if all pooling participants are characterized by the same level of risk aversion $a_i > 0$, the effect of pooling is different for every participating insurer. This is due to diverging distributions of assets and claims as well as to the different correlation structure between those variables. In general, some policyholder collectives can be worse off after the introduction of an insurance guaranty fund. Even when all policyholders of all companies would benefit from an insurance guaranty fund (in this case, Inequality (6) would be fulfilled for all participants), the utility increase would in general differ among companies. This finding is intensified if, for example, different policyholder collectives valuate their own wealth positions according to different utility functions.

Using some kind of risk-based premium principle based on the loss distribution $(\tilde{S}_i^{(1)} - \tilde{A}_i^{(1)})$ of the insurer i would not change our general line of reasoning. In this case, it again cannot be excluded that some companies will (and other will not) benefit from an insurance guaranty fund. We believe that, in an incomplete market, a non-arbitrary way of allocating the existing diversification benefits back to the pool participants via a particular premium principle is not possible, since we face a problem that is similar to the capital allocation dilemma that the academic literature has extensively discussed in the last few years (cf., e.g., Phillips et al. 1998; Myers and Read 2001; Sherris 2006; Gründl and Schmeiser 2007). Hence, the postulate of an insurance guaranty fund charging premiums that should be fair according to the risk born by an insurer leads in general to some form of a utility transfer between the insurance companies pooled in the insurance guaranty fund. Such a transfer may under certain conditions be justified, if, e.g., the proposed guaranty fund leads to a considerable reduction of agency problems as described in Sect. 2.

5.2 Utility-based premiums in the general case

As stated above, the benefits of pooling claims within an insurance guaranty fund may differ widely among participants. Beside the used premium principle, the potential advantages or disadvantages from pooling are closely tied to the portfolio composition of the insurer as well as the fund. One of possible ways to derive the insurance guaranty fund premium is the premium calculation based on the individual utility of the participating policyholder collectives. More precisely, we could demand a premium calculation for all M companies that leads to an equal utility increase for all M participants. Such a calculation is possible, if for each company $i \in \mathcal{C}$ there exists a premium $\pi_i^{(0)}$—accounting for the available amount of assets $A_i^{(0)}$ and solvency regulations in force—such that the preset (non-zero) utility increase can be reached.

When the payoff structure for the guaranty fund is defined, as, e.g., given in Sect. 5.3, the change in utility in $t=1$, $\Delta_{\mathrm{a}}\phi_i^{(1)}$ (see (4)), from the setup without to the one with an insurance guaranty fund can be calculated for all companies $i \in \mathcal{C}$ with given preferences a_i. The utility states $\phi_i^{(1)}$ and $\phi_i^{(1),\mathrm{f}}$, as well as the change in utility $\Delta_{\mathrm{a}}\phi_i^{(1)}$ are considered here as function of the premiums $\pi_i^{(0)}$ charged from all companies: $\phi_i^{(1)} = \phi_i^{(1)}(\mathbf{\Pi}^{(0)})$, $\phi_i^{(1),\mathrm{f}} = \phi_i^{(1),\mathrm{f}}(\mathbf{\Pi}^{(0)})$, $\Delta_{\mathrm{a}}\phi_i^{(1)} = \Delta_{\mathrm{a}}\phi_i^{(1)}(\mathbf{\Pi}^{(0)})$.

We can evaluate the set $\mathcal{S}_K$ of possible premium combinations $\mathbf{\Pi}^{(0)}$ for given utility change parameter $K \in \mathbb{R}$, by the following procedure of finding

$$\text{Premiums } \mathbf{\Pi}^{(0)} = \left(\pi_i^{(0)}\right)_{i\in\mathcal{C}} \quad \text{such that } \Delta_{\mathrm{a}}\phi_i^{(1)}(\mathbf{\Pi}^{(0)}) = K,\ \forall i \in \mathcal{C}. \tag{7}$$

Depending on the magnitude of the parameter K this procedure yields a set of premium combinations $\mathbf{\Pi}^{(0)}$ such that the overall (absolute) change in utility $\Delta_{\mathrm{a}}\phi_i^{(1)}$ is equal for all participants (premium principle). An optimization calculus can define the premium combination such that the change in utility is maximized, i.e. the maximum of K such that there exists a solution $\mathbf{\Pi}^{(0)} \in \mathcal{S}_K$. Numerical examples for the application of the utility-based premium principle can be found in Rymaszewski et al. (2010).

5.3 An exemplary payoff structure

The exemplary payoff scheme for an insurance guaranty fund formally derived by Rymaszewski et al. (2010) is not only proven to be self-supporting, i.e., to fulfill

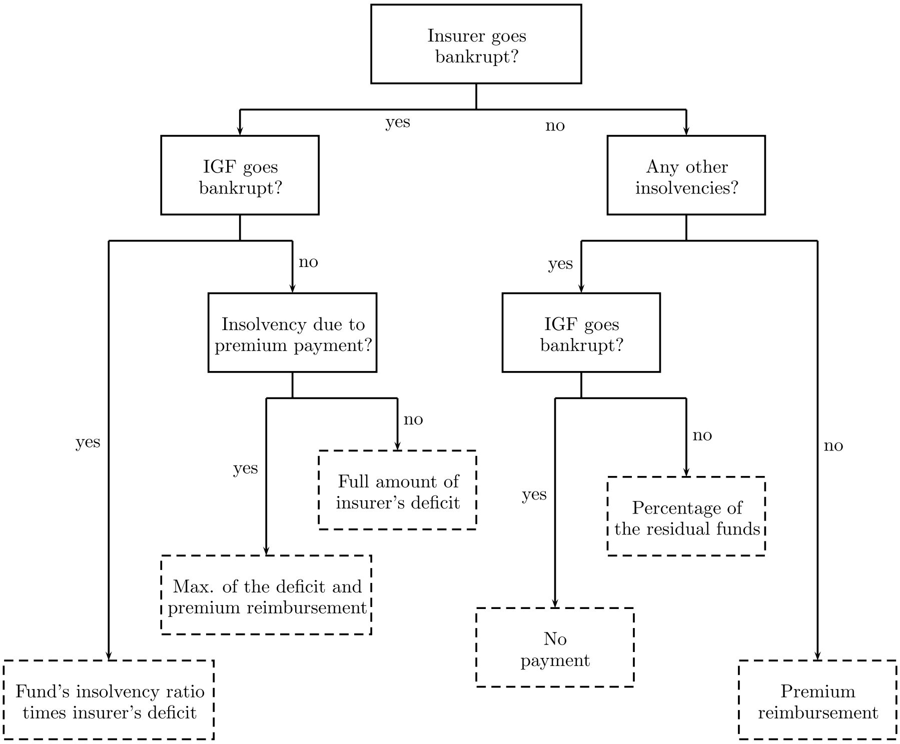

Fig. 1 Contingent payoff $\tilde{F}_i^{(1)}$ from the insurance guaranty fund (IGF) to the insurer. See Rymaszewski et al. (2010) for a formal illustration

Condition (3), but is also intended to establish desirable incentives for the participating insurers. Consult Fig. 1, for a summary of the payoff structure contingent on the situation of the insurer and the insurance guaranty fund. In general, a chance for premium refund to solvent companies in case the insurance guaranty fund does not go bankrupt can encourage the companies to limit not only their own risk, but also to monitor their rivals. Moreover, the issue of insurance companies which went bankrupt solely due to the existence of an insurance guaranty fund should be adequately addressed within the payoff scheme in order to reduce potential resistance against its introduction.

5.4 Particular case of homogeneous companies charged identical premiums

In the case where all M companies on the market are homogeneous, and are charged an identical premium $\pi^{(0)}$—as they should be if we aim at charging risk-adjusted premiums—, we have $\langle \tilde{F}_i^{(1)} \rangle = \langle \tilde{\pi}^{(1)} \rangle$, $\forall i \in \mathcal{C}$. If their policyholders have the same positive risk-aversion parameters $a_i = a > 0$, whenever this premium $\pi^{(0)}$ goes along with a fulfillment of Inequality (6), all groups of policyholders are better off to the same extent (compared to the situation without an insurance guaranty fund). Rymaszewski et al. (2010) illustrate this effect by means of a numerical example.

6 Summary

The contingent claim approach is often suggested in the literature as an approach to derive risk-based premiums, which should be charged by an insurance guaranty fund for the protection it offers against insurers' insolvencies. However, we make the point that within complete markets, the introduction of such an insurance guaranty fund cannot improve the wealth position of the policyholders if all stakes are priced fairly. If we abandon the assumption of a complete market, we also show that risk-neutral investors cannot be made better off through the existence of a self-supporting insurance guaranty fund. Hence, if the roll-out of a self-supporting insurance guaranty fund implies transaction costs, its introduction is detrimental to the insureds in both cases.

Matters may change in the more likely case of risk-averse investors and incomplete markets. The potential diversification benefit, which might be achieved by pooling claims in an insurance guaranty fund, may improve insureds' wealth position. However, a diversification advantage (or disadvantage) measured through the increase in policyholders' utility, is only equal for every single insurer if companies are homogeneous, exhibit the same utility function, and an identical degree of risk aversion.

The problem of allocating possible diversification benefits attained in an insurance guaranty fund back to heterogeneous insurance companies in an incomplete market setting with risk-averse policyholders is similar to the capital allocation problem widely discussed in the academic literature within the last couple of years. Following this line of reasoning, no non-arbitrary allocation of the collective premium within an insurance guaranty fund back to the different insurance companies is possible if the conditions of a complete market are not fulfilled. Different premium principles used to derive the fund charges (for instance, based on the individual risk profile of an insurer) lead, in general, to a situation in which policyholders are treated unequally—in the sense of a utility increase—through the introduction of an insurance guaranty fund. Even if each policyholder enjoys a diversification benefit, some insureds will be better off than others. To counteract this effect, we introduce the concept of a utility-based premium calculation principle to derive charges for an insurance guaranty fund and discuss its implications within the insurance market.

References

Brewer-III, E., Mondschean, Th.S., Strahan, Ph.E.: The role of monitoring in reducing the moral hazard problem associated with government guarantees: evidence from the life insurance industry. J. Risk Insur. **64**(2), 301–322 (1997)

Cochrane, J.H.: Asset Pricing, 2nd edn. Princeton University Press, Princeton (2005)

Cummins, J.D.: Risk-based premiums for insurance guaranty funds. J. Finance **43**(4), 823–839 (1988)

Downs, D.H., Sommer, D.W.: Monitoring, ownership, and risk-taking: the impact of guaranty funds. J. Risk Insur. **66**(3), 477–497 (1999)

Duan, J.-C., Yu, M.-T.: Fair insurance guaranty premia in the presence of risk-based capital regulations, stochastic interest rate and catastrophe risk. J. Bank. Finance **29**(10), 2435–2454 (2005)

Feldhaus, W.R., Kazenski, P.M.: Risk-based guaranty fund assessments. J. Insur. Regul. **17**(1), 42–63 (1998)

Gründl, H., Schmeiser, H.: Capital allocation for insurance companies—what good IS IT? J. Risk Insur. **74**(2), 301–317 (2007)

Han, L.-M., Lai, G.C., Witt, R.C.: A financial-economic evaluation of insurance guaranty fund system: an agency cost perspective. J. Bank. Finance **21**(8), 1107–1129 (1997)

Lee, S.-J., Mayers, D., Smith, C.W.: Guaranty funds and risk-taking evidence from the insurance industry. J. Financ. Econ. **44**, 3–24 (1997)

Myers, S.C., Read, J.A. Jr.: Capital allocation for insurance companies. J. Risk Insur. **68**(4), 545–580 (2001)

Oxera: Insurance guarantee schemes in the EU: comparative analysis of existing schemes, analysis of problems and evaluation of options (2007). URL http://ec.europa.eu/internal_market/insurance/docs/guarantee_schemes%_en.pdf

Phillips, R.D., Cummins, J.D., Allen, F.: Financial pricing of insurance in the multiple-line insurance company. J. Risk Insur. **65**(4), 597–636 (1998)

Rymaszewski, P., Schmeiser, H., Wagner, J.: Under which conditions is an insurance guaranty fund beneficial for policyholders? Working Paper, University of St. Gallen (2010)

Sherris, M.: Solvency, capital allocation, and fair rate of return in insurance. J. Risk Insur. **73**(1), 71–96 (2006)

Sommer, D.W.: The impact of firm risk on property-liability insurance prices. J. Risk Insur. **63**(4), 597–636 (1996)